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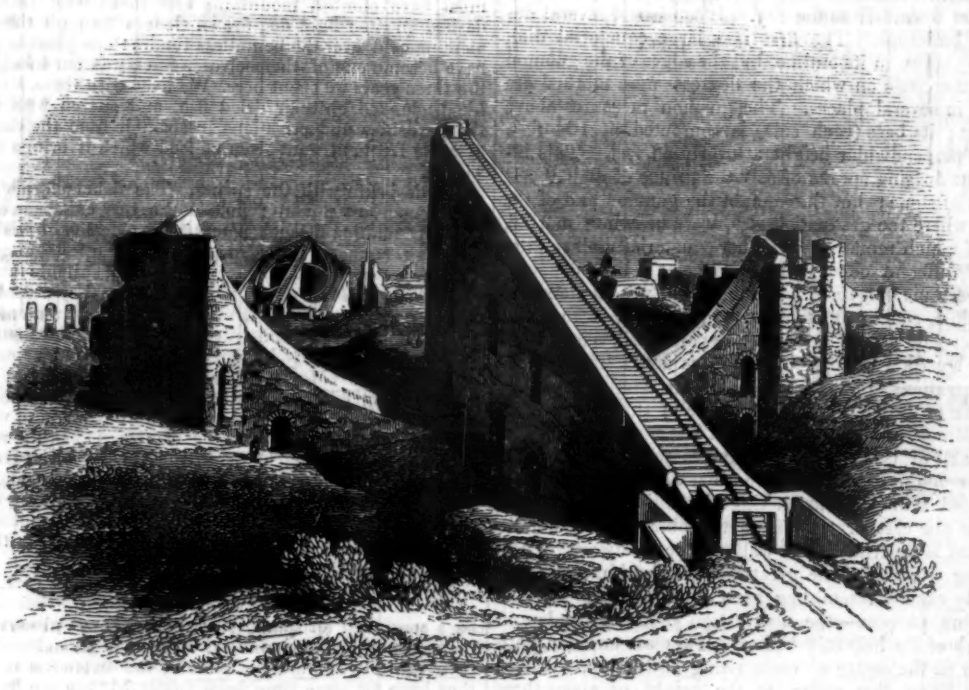
THE OBSERVATORY AT DELHI.



[The Observatory at Delhi.]

THE Gentur Muntur (or Royal Observatory) of Delhi was built by Rajah Jeysing, in the reign of Mohammed Shah, about the year 1710. The immediate objects for which it was erected may be best understood from his own published account.* "Sewai-Jeysing, from the first dawning of reason in his mind, and during its progress towards maturity, was entirely devoted to the study of mathematical science, and the bent of his mind was constantly directed to the solution of its most difficult problems; by the aid of the supreme artificer he obtained a thorough knowledge of its principles and rules. He found that the calculation of the places of the stars, as obtained from the tables in common use, gives them widely different from those determined by observation: especially the appearance of the new moons. Seeing that very important affairs both regarding religion and the administration of empire depend upon these; and that in the time of the rising and setting of the planets, and the seasons of eclipses of the sun and moon, many considerable disagreements of a similar nature were found;" he represented the matter to Mohammed Shah, whom Jeysing terms, in language that proves him as apt a courtier as he was truly a learned and able scientific man, "his majesty of dignity and power, the sun of the firmament of felicity and dominion, the splendour of the forehead of imperial magnificence, the unrivalled pearl of the sea of sovereignty, the incomparably brightest star of the heaven of empire; whose standard is the sun, whose retinue the moon; whose lance is Mars, and his pen like Mercury; with attendants like Venus; whose threshold is the sky, whose signet is Jupiter, whose sentinel Saturn; the emperor descended from a long line of kings; an Alexander in dignity; the shadow of God; the victorious king Mohammed Shah, may he ever be triumphant in battle!" A reply was given to his representation. "Since you who are learned in the mysteries of science, have a perfect knowledge of this matter, having assembled the astronomers and geometricians of the faith of Islam, and the Bramins and Pundits, and the astronomers of Europe, and having prepared all the apparatus of an observatory, do you so labour for the ascertaining of the point in question, that the disagreement between the calculated times of those phenomena and the times in which they are observed to happen may be rectified." Jeysing justly remarks that this was a "mighty task," but having "bound the girdle of resolution about the loins of his soul," he constructed several of the instruments of an observatory in brass. "But finding that brass instruments did not come up to the ideas which he had formed of accuracy, because of the smallness of the size, the want of division into minutes, the shaking and wearing of their axes, the displacement of the centre of the circles, and the shifting of the planes of the instruments," he erected the existing great works "of stone and lime, of perfect stability, with attention to the rules of geometry, and adjustments to the meridian, and to the latitude of the

* See 'Some Account of the Astronomical Labours of Jayascinha, Rajah of Ambbere, or Jayanaga,' by W. Hunter, Esq., in 'Asiatic Researches.' To this paper we are indebted for the information contained in the following account.

place." He found the new instruments successful, but in order to confirm the accuracy of the observations made by them, he caused others of a similar kind to be constructed in Sewaï Jeypoor, Matra, Benares, and Ougein; and found his first calculations verified. Jeysing presented his new set of tables to the emperor, who stamped them with his approbation. The almanacs of Delhi and all astronomical conputations are still made from these tables.

The Observatory is situated among piles of ruinous palaces, attesting most impressively the former but lost magnificence of Delhi without the gates, about a mile and a quarter distant from the city. It consists of several detached buildings. The first is a large equatorial dial, tolerably entire in its outline, but the edges of the gnomon and of the circle on which the degrees were marked are broken in several places. The gnomon measures above 118 feet; its base (each side) is computed at 104 feet, and its perpendicular height at nearly 57 feet. This instrument Jeysing speaks of as "the prince of dials." It is built of stone; but the edges of the gnomon and of the arches where the graduation was, were of white marble, little of which remains. Another equatorial dial, smaller and of different construction, stands at a little distance, in a very perfect state. The gnomon, which stands in the middle, contains a staircase leading up to its top, and on either side of the gnomon are concentric semicircles, having a certain inclination to the horizon. They represent meridians, removed by a certain angle from the meridian of the place. On each side of this part is another gnomon, of equal size to that last mentioned. The north wall of this structure connects the three gnomons at their highest end; and on this wall is described a graduated semicircle for taking the altitudes of bodies that lie due east or west from the observer. A double quadrant is described on a wall to the westward of the building. South of the great dial are two buildings, apparently exactly resembling each other, and adapted for the same purpose—the observation of the altitude and azimuth of the heavenly bodies. They are circular, with a pillar in the centre of each, rising to the top, which is open. From this pillar, at the height of about three feet, branch horizontal radii of stone to the circular wall. The radii are thirty in number; the spaces between them are equal to the radii, which increase in breadth as they recede from the pillar. In the wall, at the spaces between the radii, are recesses with holes, to enable a person to climb to the top, and containing each of them two windows. On the edges of the recesses are marked the degrees of the sun's altitude, as shown by the shadow of the pillar. The degrees are again subdivided into minutes. The spaces in the wall are divided into six equal parts or degrees, by lines drawn from the top to the bottom. By observing on which of these the shadow of the pillar falls, the sun's azimuth is determined. The altitude and azimuth of the moon and of a star may also be found by means of this erection. The dimensions of the building are thus given by Mr. Hunter:—Circumference of the building, 172 feet 6 inches; of the pillar, 17 feet; length of each of the radii, 24 feet 6 inches. The height of the building is not stated. Mr. Hunter remarks, "I do not see how observations can be made when the shadow falls on the spaces between the stone radii or sectors; and from reflecting on them, I am inclined to think that the two instruments, instead of being duplicate, may be supplementary one to the other; the sectors in one corresponding to the vacant spaces in the other, so that in one or other an observation of any body visible above the horizon might at any time be made." Between these two buildings and the great equatorial dial is an instrument, formed of mahogany, in the shape of a concave hemispherical surface, to represent the inferior hemisphere of the heavens. It is divided by six ribs of solid work and as many hollow spaces, the edges of which represent meridians, at the distance of 15 degrees from each other. The diameter of this work is 27 feet 5 inches.

LIFE IN SIBERIA.

[From the 'Survey of the North-Eastern Coast of Siberia,' by Von Wrangel, translated in the 'Foreign Quarterly Review.']

To form a just conception of life on the banks of the Kolyma, says M. von Wrangel, one must have spent some time with the inhabitants. One must have seen them in their winter dwellings and in their summer *balagans;* one must have shot down their rapid streams in the light canoe, must have climbed mountains and rocks with them, or dashed in their light dog-drawn sledges through the most piercing cold over the boundless tundra; one must in short have become one of themselves. Such was our life during the three years we spent here. We lived with them, dressed like them, fed on their dried fish, and shared with them the hardships and privations inseparable from the climate, and the frequent want even of food which it brings along with it.

Let us begin with the spring. The fishery forms their most important pursuit; indeed the very existence of the whole population depends upon it. The locality of Nishney-Kolymsk, however, is unfavourable, and the inhabitants are obliged to migrate at this season to more suitable parts of the river. As soon as the winter ceases, they accordingly abandon their dwellings in search of some convenient spot, where they forthwith construct a *balagan*, or light summer hut, and immediately commence their hostilities upon the piscatory tribe. Most of the Nishney-Kolymskites have regular country-houses of this description at the mouths of the several creeks and rivulets, which they begin to visit in April, in order to prepare for the campaign. In the middle of May, when the merchants arrive from the fair of Ostrownoye, on their return to Yakoutsk, the whole population abandons the little place, leaving the whole town to the guardianship of one Cossack sentinel, and perhaps one or two old women, whom age prevents from joining in the general pursuit.

Spring is the most trying season of the whole year. The store collected during the summer and autumn has usually been consumed for some time; the fish do not always make their appearance immediately, and the dogs, exhausted by their winter work, and yet more by the severe fast to which they have for some time been subjected, are too feeble to allow their masters to avail themselves of the *nast*,* to catch a few elks and wild reindeer. Famine then appears in its most horrible form. Crowds of Tungusians and Yukaheers come flocking into the Russian villages in search of some subsistence. Pale and ghost-like they stagger about, and greedily devour every species of garbage that falls in their way. Bones, skins, thongs of leather, everything in short that the stomach will receive, is eagerly converted into food. But small is the relief they find; for the unthrifty townspeople are by this time almost as ill off themselves, and living upon the scanty remnant of fodder stored up for the use of the dogs, so that many of these faithful and valuable animals perish nearly every year of hunger. There is a storehouse established by the government, where rye-flour is sold to every comer; but the expense of conveying it from so enormous a distance enhances the price to such a degree that few are able to avail themselves of the facility thus afforded them. Although the additional accommodation is granted them of not paying before autumn, still there are not many who can afford to give twenty rubles for a pood of flour, which moreover has often been damaged during the protracted journey it has had to perform. Three of these periods of horror did I witness, during three succeeding springs, and even now I shudder when I reflect on the scenes of suffering which I beheld, and of which it would be utterly impossible for me to attempt a description.

It is just when famine is at its worst that relief arrives. Suddenly countless swarms of birds make their appearance. Swans, geese, ducks, and several descriptions of snipes.

* When the warmth of the spring sun thaws the surface of the snow, it freezes again during the night, whereby a thin crust of ice is formed, strong enough to bear a sledge with its team of dogs. In this condition the snow is called *nast*, over which the elks and reindeer are pursued during the night; and as, owing to their greater weight, they are constantly breaking through the ice, they are caught by the hunters with little trouble.

These are the first heralds of spring, and at their coming hunger and want are at an end. Old and young, men and women, all that can walk or run, now rush out with guns, bows, and sticks, to kill as many as they may. In June the ice breaks up, a profusion of fish comes crowding into the river, and all hands are in movement to avail themselves of the short season of grace to provide a store for the coming year. But here a new misfortune often assails them. The stream is not strong enough to float away with sufficient rapidity the mighty masses of ice. These accumulate in the narrows and shoals, and the water, arrested in its course, quickly overflows the whole of the low country, and, if the inhabitants are not quick enough in driving their horses to the hills, the poor animals are infallibly lost. In the summer of 1822 we had such an inundation at Nishney-Kolymsk, which came upon us so suddenly that we had only just time to take refuge with a few of our most indispensable articles upon the flat roofs of our huts, where we were forced to remain for upwards of a week. The water rushed with fearful rapidity between the houses, and the whole place looked like a little archipelago of house-tops, among which the inhabitants were merrily rowing about in their canoes, paying one another friendly visits and catching fish.

More or less these inundations occur every year, and when the waters subside the main fishery with nets begins. Fish form the chief food of man and dog, and for the yearly consumption of the hundred families that compose the little community of Nishney-Kolymsk, at least three millions of herrings are required. Many other kinds of fish are caught at this time, among which is the *Nelma*, a large description of salmon-trout, but the first fish are generally thin, and are mostly converted into *yukhala* for the dogs; that is to say, cut open, cleaned, and dried in the air. From the entrails an abundance of train-oil is obtained, which is used for food as well as for fuel. The *yukala* is distinguished from the *yukhala* merely by the selection of a better kind of fish, and by greater care in the preparation.

The proper season for bird-hunting is when the animals are moulting, when, having lost their feathers, they are unable to fly. Large detachments are then sent off from the fishing-stations, and numbers of swans and geese are killed with guns, bows, and sticks. The produce of this chase is said to have diminished greatly of late years. Formerly it was no unusual thing for the hunters to bring home several thousands of geese in one day, whereas now they are content if they can catch as many during the whole season.

While the men are fishing and hunting, the women make the best use of the interval of fine weather, to collect the scanty harvest which the vegetable kingdom yields them, in the shape of a few berries and aromatic herbs. The gathering in of the berries is a season of gaiety, like the vintage in southern climes. The young women wander about in large parties, spending the nights in the open air, and amusing themselves with song and dance, and other innocent diversions. The berries themselves are preserved by pouring cold water over them, and freezing them, in which condition they form one of the favourite dainties during the winter. Besides the berries, they collect at this time the *makarsha*, a mealy root found in large quantities in the subterranean storehouses of the field-mice. The young girls appear to have a peculiar tact in discovering the magazines of these little notable animals, whom, without the least remorse, they plunder of the fruits of their provident industry.

Patriarchal Customs.—There is a distinct race of people in the mountains of Austrian Galicia, whose habits are singularly patriarchal. Whole families, with their entire offspring, sons, daughters, cousins, and grandchildren, continue to abide under one and the same roof so long as it can be made to contain them, obeying the behests of the elder father as their lord paramount. The same vestige of ancient times prevails among the Rusnacks (originally Sclavonic-Russians) of the Galician plains. The father is lord and master over the family; every arrangement, even to the very employments of the female sex, depends upon his sovereign will. He appoints the work to be done by his sons and his daughters-in-law, according to their respective qualifications. His will is implicitly obeyed by all around him, and his interference sets every domestic variance at rest. To one son he gives charge of the cattle; another he sends abroad with his waggon and horses; and however great the number of males under his roof, for each he finds some distinct occupation. One of his daughters is commissioned to assist her mother in household concerns, another has the spindle assigned to her, a third the loom, and a fourth is sent out to sell the linen made in the family. These homesteads contain within themselves their own builder, wheelwright, carpenter, joiner, tailor, and shoemaker; and their kitchens are better ordered and their tables more substantially garnished than those of any of their neighbours. In every dwelling there is a small chamber, to which the elder of the family alone has the key, where he deposits his savings, all in gold or silver, and sometimes of no trivial amount: neither wife nor children ever venture to inquire into its extent. When their waggons go upon long journeys, a white horse is always one of the team; the reason they give for this custom is, that, as they turn them loose at night to graze, the white horse enables them readily to track them if they stray afar; and he is also a rallying point for his comrades. Robbery and murder, if not unknown among them, are at least of exceedingly rare occurrence; a circumstance which is fully borne out by the reports of the criminal courts.—*J. G. Kohl.*

Factory Baths.—In the autumn of last year I established some warm baths, which have been brought into very general use, and have contributed materially to the health, comfort, and cleanliness of the people. The bathing-room is a small building close behind the mill, about twenty-five feet by fifteen. The baths, to the number of seven, are ranged along the walls, and a screen about six feet high, with benches on each side of it, is fixed down the middle of the room. The cold water is supplied from a cistern above the engine-house, and the hot water from a large tub, which receives the waste steam from the dressing-room, and is kept constantly almost at boiling temperature. A pipe from each of these cisterns opens into every bath; so that they are ready for instant use. The men and women bathe on alternate days, and a bath-keeper for each attends for an hour and a half in the evening. This person has the entire care of the room, and is answerable for everything that goes on in it. When any one wishes to bathe, he comes to the counting-house for a ticket, for which he pays a penny, and without which he cannot be admitted to the bathing-room. Some families, however, subscribe a shilling a month, which entitles them to five baths weekly; and others hold a *general* subscriber's ticket, which always gives them admittance to the room. I think the number of baths taken weekly varies from about twenty-five to seventy or eighty. During the first four months (from November to February inclusive) the average was about seventy-five weekly. I pay the bath-keepers two shillings and sixpence and two shillings a-week; and I believe this amount has been more than covered by the receipts. The first cost of erecting the baths was about eighty pounds.—*Letter to Mr. Leonard Horner.*

Dilemmas.—One of the most celebrated dilemmas is one of the most ancient. A rhetorician had instructed a youth in the art of pleading, on condition that he was to be remunerated only in case his pupil should gain the first cause in which he was engaged. The youth immediately brought an action against his teacher, of which the object was, to be freed from the obligation which he had contracted, and then endeavoured to perplex his instructor with this dilemma. "If I gain my suit," said he, "the authority of the court will absolve me from paying you; If I lose, I am exonerated by our contract." The rhetorician answered by a similar dilemma: "If you gain your suit, you must pay me according to our contract; if you lose the suit, you must pay in compliance with the decision of the court." A just but severe man built a gallows on a bridge, and asked every passenger whither he was going; if he answered truly, he passed unharmed; if falsely, he was hanged on the gallows. One day a passenger, being asked the usual question, answered, "I am going to be hanged on the gallows." "Now," said the gallows-builder, "If I hang this man, he will have answered this truly, and ought not to have been hanged; if I do not hang him, he will have answered falsely, and ought to have been hanged." It is not recorded what decision he came to.—*Book of Table-Talk.*

THE HERONRY.

[From a Correspondent.]

[The Heronry on the River Findhorn, Morayshire.]

There are few, if indeed any objects which tend so much to diversify and adorn the countries in which they are placed, and through which they wander, as rivers. While the mountains remain immoveable in their grandeur, and the forests occupy the same station from their youth till their decay, there is an ever-changing diversity of beauty in the waters, which captivates and delights the eye. We trace them from their source, follow them in their windings, behold them expand as they lengthen in their race, —receiving the accumulating tribute of a hundred streams,—and at last view them calmly gliding to the rest which awaits them in the bosom of the mighty ocean.

If Scotland cannot boast of the magnitude of her rivers, she can at least say much of their multiplicity. The Clyde, the Tweed, the Tay, the Forth, the Spey, Don, Dee, and Findhorn are all names of note. Each has a character of its own, which, of course, it receives from the district through which it flows. Some all grace and beauty, others rough and rugged as the rocks over which they rush and roar in their career. To the latter class, for a considerable part of its way, belongs the Findhorn. It takes its rise among the hills of Badenoch, in the shire of Inverness, and flows north-east through part of that shire, as also those of Nairn and Moray, till at length, about fifty miles from its source, it empties itself into the Moray Frith, at the little port which bears its name.

The scene which we have selected for illustration is one which has long been celebrated in its neighbourhood, and few are the travellers who journey in its vicinity without paying it a visit. As it is little more than four miles south-west from the town of Forres, we shall suppose the stranger starts from thence, and accompany him. There are two methods of proceeding, either by walking along the side of the river, or taking the Highland road to the point from whence we strike off. The former is certainly the more pleasing of the two, but liable to an objection, inasmuch as the eye gets accustomed to the beauty of the scenery, and the impression or novelty wears off ere the principal spot be attained. We therefore prefer the latter, and a duller, or one more calculated to sober down the imagination, need not be desired. However, we have arrived at a bye-path, leading through a forest of firs, with the monotony of whose appearance our eyes have for the last half-hour been overfamiliar, and a few minutes' walk brings us to a halt on an eminence. We are at the Heronry.

What a delicious panoramic view is now spread before us! The river, for the last three miles of its course, has been confined within narrow limits by the approaching rocks between which it flows. It here widens, and flows in a gentler motion, unimpeded by opposing obstacles. On the right there rise rocks of a reddish freestone, over which the birch and the ash droop their graceful branches. On the left, some hundreds of feet beneath the spectator, and on the opposite side, a colony of herons have established their abode. From this circumstance the spot derives its name. The trees, on which the majority of their nests are built, are venerable from their age, and have, in all probability, supported these 'procreant cradles' for many generations. Meadows of luxuriant verdure next meet the eye, where, if tradition can be trusted, gallant knights once assembled to exhibit their feats in tilt and tourney, while gay ladies displayed their charms and cheered them with their smiles. In our quieter times, the browsing cattle give an air of pastoral beauty and repose, which is more in accordance with the scene than the din of arms or the pomp of chivalry. Rising from the margin of these, we behold the outskirts of the far-spreading forests of Darnoway, embosomed in which is the castellated mansion of the noble proprietor, the Earl of Moray, containing the famous hall of Randolph, with its carved oak ceiling,—one of the finest specimens of that work in the kingdom. From the point where we lose sight of the river, the whole country seems wooded even to the Frith; this, however, is a visual illusion, there being

some miles of well cultivated land between, but lying too low for the range of the eye. The line of white hills which appear to the right, in the distance, are certain elevations of sand, which are supposed to have arisen from some convulsive irruption of the German Ocean, and buried beneath them one of the most fertile portions of the province—the estate of Culbin—somewhere about the beginning of the eighteenth century. They are now called the sand-hills of Culbin. The Moray Frith, spotted with the white sails of passing vessels, and the shores of Ross, Caithness, and Sutherland, bound the prospect.

Such is a limited enumeration of the more prominent objects in this interesting and diversified landscape. But words cannot always do justice to the full loveliness of nature. We can easily describe the appearances of things; but to experience the countless feelings which these engender, actual contemplation is necessary. In some respects, a beautiful country is at all times beautiful; but there are seasons when that beauty is heightened. In the noontide of a midsummer day, the Heronry will not appear so striking, from the uniformity of tone which pervades it; but at the sunset of an autumnal afternoon, when the western heaven is a-flame with the brightness of the sinking luminary, and every tree mantled with golden foliage, the murmuring of the river—darkened by the shadows of innumerable branches—blending sweetly, and not without a "something of sadness," with the cry of the heron as he sails in many a proud sweep over his home—then is the true hour for gazing on the view, and cold would be the heart of the spectator who would not sigh, as he turned with regretful step, at leaving such an enchanting scene to the evening cloudiness which would so soon overshade it.

The long-necked heron is a very elegant bird, and in flying its motions are extremely graceful. Its food consists of the smaller sorts of fish, worms, frogs, &c. At a period not very remote from our own, they afforded sport to the magnates of the land, in the royal and noble exercise of hawking. The rocks of the Findhorn were long celebrated for the excellence of the hawks which established themselves in their crevices. They were called Darnoway hawks, and are eulogised in the 'Abbot,' in the dialogue between Michael Wing-the-Wind and Adam Woodcock, in the 'Hostelry of Holyrood.' But times are changed, and instead of the fair lady with the falcon on her wrist, the heron has now only to dread for an enemy the truant schoolboy, who, at the risk of his life, despoils it of its eggs.

ON MEASURES OF LENGTH AND CAPACITY.

We lately presented a brief sketch of the principal changes which have from time to time been made in the measures of *weight* in this country, and on the principle by which weight is determined through the means of a pair of scales, a steelyard, &c. These details may consistently be followed by a notice of the measures of *length* and of *capacity* used in England and in France.

We had occasion, in the papers just alluded to, to state that the first rough attempt to obtain a standard of length in this country was by taking the length of the arm of one of our early kings, and calling that length a *yard*. It is probable that a metallic bar was made of that exact length, to serve as a standard from whence commercial yard-measures might be made. In some of our old arithmetical tables, we are instructed that "Three barley-corns make one inch; twelve inches, one foot; three feet, one yard." It is not now possible to say when this unit of measure sprang up; but it is evident, from its rudeness and inaccuracy, that its origin must be dated from a very early period; and we may reasonably doubt whether the "yard" derived from the length of a king's arm precisely equalled that derived from the length of 108 barley-corns. There appears to have been a tendency in many countries to make the human body in various ways a standard of length; and many terms more or less in use at present in England point to the existence of this custom;—thus, the *fathom* was the utmost extent which a man could fathom or reach when the arms were stretched out to the full extent, measuring from the finger-end of one hand to that of the other; and this was farther deemed to be equal to the height of the same individual:—the length of the *pace* was taken at one half of the stature; of the *foot*, one-sixth; and the *span* (the distance from the thumb to the little finger of an expanded hand), equal to one-eighth;—the *hand-breadth*, the *thumb-breadth*, and the *finger-breadth* equal respectively to one-third, one-twelfth, and one-eighteenth of the length of the foot. These measures of course vary in different individuals, whether symmetrically formed or not, and in course of time the *fathom* became deemed equivalent to two yards, although that is certainly beyond the stretch of the arms of the majority of men. By fixing the value of the fathom at two yards, we find that the *pace* is one yard, the *foot* a third of a yard, the *span* nine inches, the *hand-breadth* four inches, the *thumb-breadth* an inch, and the *finger-breadth* two-thirds of an inch. That something equivalent to this prevailed in France is shown by the circumstance, that the French word *pouce* means both thumb and inch; and in Germany the same rule used to be followed: the German for inch is *zoll*, and under the word zoll, in an old German dictionary, we find, "zoll, ein daum-breit," a thumb-breadth, the twelfth part of a foot.

But throughout this arrangement we see that we do nothing towards obtaining a real standard of length, for thumb-breadths and foot-lengths vary as much as the stature of men: it is well enough to say that a fathom shall equal two yards, but then we must know precisely what a yard means. Hence we see the necessity of having a measure of length, formed of metal or some other durable material, which shall serve as a standard from one age to another; and there appears to have been a standard of this kind kept for some centuries in England; but the first attempt at making a scientific examination of this standard was in the last century.

It is stated in the 'Philosophical Transactions,' that in 1742, "some curious gentlemen, both of the Royal Society of London and of the Royal Academy of Sciences at Paris (thinking it might be of good use for the better comparing together the success of experiments made in England and in France), proposed that accurate standards of the measures and weights of both nations, carefully examined and made to agree with each other, might be laid up and preserved in the archives both of the Royal Society and of the Royal Academy of Sciences at Paris; which proposal having been received with the general approbation of both those bodies, they were pleased to give the necessary directions for carrying the same into effect." Two well-squared brass rods, about three feet and a half long each, were carefully graduated by Graham from the standard yard kept at the Tower: they were then sent to France, and graduated from the Paris half-toise (the toise, = 6·395 English feet, being the standard of length in France at that time). One of the doubly-graduated rods was then kept at Paris, and the other returned back to London: the latter subsequently had the yard and the half-toise each divided into three equal parts, forming respectively English feet and French feet. The rods were then laid up in the archives of the two Societies, where we believe they still remain.

Shortly afterwards, the Royal Society's standard was compared with those kept at the Exchequer: these were, a standard yard made in the time of Henry VIII., and long disused,—a yard, and an ell, each made of brass rods of the breadth and thickness of half an inch, the ell being equal to one yard and a quarter, and both hav-

ing been in use since the time of Queen Elizabeth. Guildhall contained two standard measures of length at the same time, one of a yard and the other of an ell. The Clock-Makers' Company also possessed a brass standard yard, presented to them from the Exchequer in 1671. In some of these cases, the standard consisted of a rod exactly an ell or a yard in length; in others, of a longer rod with a portion of its length graduated; and in others, of a matrix or bed with two pins inserted at the prescribed distances. All these standards were carefully compared by Graham; and, taking the Exchequer yard as the true one, the others were found to vary from about one-twentieth of an inch plus to one-fifteenth of an inch minus that length. For common purposes this may seem a difference of no great importance; but in a scientific point of view it is very considerable. Graham made an additional graduation on the Royal Society's standard, equal to the Exchequer yard.

In 1758 the legislature turned attention to this subject; and after some investigations on the comparative lengths of the various standards, ordered a rod to be made of brass, about 38 or 39 inches long, and graduated from the Royal Society's yard: this was marked "Standard Yard, 1758," and was laid by in the care of the clerk of the House of Commons. For commercial purposes another bar was made, with the yard marked off from the same standard; but it had two upright fixed cheeks, placed exactly a yard asunder, between which any commercial yard measures might be placed, in order to have their accuracy tested: it was graduated into feet, one of the feet into inches, and one of the inches into ten parts. This standard was to be kept at the Exchequer. In 1760, a copy of Bird's standard, made two years before, was constructed.

Some years after this, Mr. Troughton, the eminent mathematical instrument maker, constructed a very accurate scale for his own use as a mechanician, and afterwards made a copy of it for Sir George Shuckburgh: in these scales, dots were placed at distances of one-tenth of an inch asunder along the whole scale; they were therefore not so much yard measures as measures of tenths of an inch: 360 of these divisions of course made a yard, and Mr. Troughton took as a standard a yard measure made by Bird, for Harris, assay master at the mint. These measures were for purely scientific purposes; and it was not till 1814 that parliament again interfered in the matter: the result of this interference was, that Bird's standard of 1758 was still to be deemed the English standard, and that the length of a pendulum vibrating seconds in the latitude of London was 39·13047 of those inches of which the standard yard contained 36. From 1818 to 1831, other investigations were entered into, but they ended, as before, in confirming Bird's scale of 1758, or rather the copy of it made in 1760, as the English standard; and as subsequent experiments had shown the length of the seconds pendulum to be not exactly what the former committee had determined it, it was further stated that the seconds pendulum equals 39·13929 inches of Bird's scale, and the French mètre equals 39·37079 inches, the English standard being at a temperature of 62° Fahr. These regulations were confirmed by an act of parliament made in 1824, the parliamentary standard of 1760 being called the imperial standard yard; and Mr. Baily has shown that on account of the confusion amongst the several standards, the standard yard became permanently 1-140th of a inch longer than the ancient yard of the kingdom, although such a deviation does not appear to have been contemplated. Bird's two scales, of 1758 and 1760, were destroyed in the fire which consumed the houses of parliament in 1834; so that there is at present no standard, strictly speaking, in England, for the act of 1824 declared Bird's scale of 1760 the only legal standard, and there is no exact copy of it existing, as the Exchequer standards do not precisely agree with it. Within a few years a very delicate standard has been made for the Astronomical Society, concerning which, and a comparison between its graduation and those of most of the other scales of which we have been speaking, an elaborate Report has been given by Mr. Baily, in the 9th volume of the 'Memoirs' of that Society.

It would be impossible to trace the changes that have occurred in the measures of capacity; those relating to length have been sufficiently complicated, but those of capacity have been much more so. The terms sack, bushel, gallon, have all had different significations in different parts of the country. A wine gallon contained 231 cubic inches, but a beer gallon 282 inches; and as the gallon was the unit of liquid measure, all other denominations varied in the same proportion. Again, the Winchester bushel contained 2150·42 cubic inches, whereas the coal bushel contained 2217·6 inches; there was also the very absurd custom of heaped measure for some goods, and strike measure for others. Instead of attempting to discover the sources of these discrepancies, we will show how they were dealt with by the act of 1824. Heaped measure was still continued for certain goods; but for liquids the unit of measure was declared to be the imperial gallon, everywhere equal: this gallon measure is such as to contain 10 pounds avoirdupois weight of distilled water, weighed in air of which the temperature is 62° Fahr., and barom. 30°; that this gallon should be subdivided into quarts and pints; and that multiples of it should form the peck, the bushel, and the quarter. It is found that 10 lbs. of water, under the circumstances above mentioned, measure 277·274 cubic inches, which are therefore the cubic contents of an imperial gallon. For the measurement of those substances sold by heaped measure, there were certain regulations as to what proportion the heaping shall bear to the diameter of the bushel or peck measure; but these we may pass over, for by an act which came into operation January 1, 1835, all heaped measures are abolished. Coals are now sold by weight instead of by measure; and of those commodities which are still sold by measure, the imperial gallon of 277·274 cubic inches is used, without heaping. The imperial gallon is less than the old ale gallon, but greater than the old wine gallon. Of the chaldron, the hogshead, the tun, &c. we need not here speak, for they are all derived from the gallon, and their amount may be seen in any table of weights and measures.

We must now briefly speak of the measures of length and capacity used in France. Before the introduction of the metrical system at the end of the last century, the principal measures of length were the toise, the foot, the inch, and the line; the toise being equal to six feet, and the French foot being to the English in the ratio of about 16 to 15. The measure of capacity was the boisseau (bushel), of a capacity of 656 cubic inches; and various multiples and aliquot parts were used for larger and smaller quantities of corn and other dry goods, with the names of *muid*, *septier*, *mine*, *minot*, and *litron*. For liquids there were the *pinte*, *velte*, *muid*, *feuillette*, *quartants*, and *tonneau*. All these measures, as well as the measures of land, were exceedingly variable in different parts of France; and it was one of the objects of the metrical system to introduce order into this chaos of customs. We explained, in the article on Weights, the nature of the *mètre*, viz., that it equals the ten-millionth part of the quadrant of the earth's circumference. How other measures were produced from the *mètre*, we will here explain.

The mètre is the unit of length, and other measures equal to 10, 100, &c., 1-10th, 1-100th, &c., *mètres*, have received appropriate names which instantly show their respective values. A square, the side of which equals 10 mètres, is made the unit of surface, for land measure, &c., under the name of *Are;* and this has certain multiples and aliquot parts, such as the *hectare*, *decare*,

deciare, *centiare*, &c. For measures of capacity, for liquids, &c., the unit is the *litre*, being a cube, the side of which is the tenth part of the mètre; and for coarse solid substances, such as fire-wood, the unit is the *stere*, or mètre cube, both of which are susceptible of the same modes of combination and of subdivision as we have before alluded to. All these measures, and the varieties of each, may be reduced to English terms by remembering that they are all derived from the *mètre*,—that the mètre equals about 39¼ English inches,—that the Greek prefixes *deca*, *hecato*, *kyro*, and *myrio* imply 10, 100, 1000, and 10,000,—and that the Latin prefixes *deci*, *centi*, *milli* imply 1-10th, 1-100th, 1-1000th.

It was stated in our former paper that the French government were compelled to yield to the prejudices of the people, by so arranging the new system as to permit of the use of the old and accustomed names of measures of weight. The same has occurred in other respects, and many of the measures of length and of capacity are now a sort of jumbling compound between the old system and the new. Although men of science almost universally approve of the metrical system, it does not appear to be much more in favour now than it was forty years ago among the large mass of shopkeepers and retail details. It was the difficulty thus opposed to the changing of old habits and customs that induced the English legislature, in 1824, to adhere to the old measure of length, notwithstanding its unscientific character.

EPSOM SALTS.

It frequently happens that many of the ordinary terms of social life, when adopted into the language of science, receive a very extended or a very restricted meaning, and not unfrequently a meaning entirely opposite to that conveyed by their popular use. Thus the word *salt*, in every-day language, is confined to that valuable seasoner and preserver of our food which is almost as necessary to health as bread or water is, and which has been known and in constant use from the remotest times; whereas in chemistry, the term *salt* has a very wide and comprehensive meaning, and is the generic term applied to those compound bodies formed by the combination of acids, with either alkalies, earths, or metallic oxides. There are upwards of two thousand of such compounds or salts, the properties of which are very various: some salts are sour, others bitter, others sweet, others without any taste at all; some are very pungent to the smell, and others are wholly inodorous.

Again, in popular language, the term *salts* is confined to a laxative medicine in very common use; whereas it forms only a solitary example out of the large number of salts that we have just stated. The term a "dose of salts" is by common consent applied to a union of sulphuric acid and magnesia, called sulphate of magnesia, or Epsom salts.

About the year 1695 a mineral spring at Epsom, in Surrey, was in high repute; and in order to extend the benefits of this spring, an attempt was made to extract its saline matters by evaporating the water: the attempt succeeded, and a salt was procured, which, from the place of its origin, obtained the name of Epsom salts. As chemical science improved, cheaper and more abundant sources of the salt were discovered. It was not only traced in the water of Sedlitz and other springs, but also in union with lime, in a class of rocks called magnesian limestone. It has also been discovered in sea-water.

There are several modes of obtaining Epsom salts on a large scale, some of which we will briefly describe.

When the source is magnesian limestone, the stone is first broken up into small pieces, and a quantity of sulphuric acid, diluted with water, is added. By the action of the acid, two compounds are formed, viz. 1st, *sulphate of lime*, which is a hard, solid, white, insoluble substance, commonly known by the name of plaster of Paris; and 2nd, *sulphate of magnesia*, which is soluble. Now the peculiar value of this process is, that of the two compounds which are formed by the addition of sulphuric acid to the magnesian limestone, one is insoluble, and remains at the bottom of the vessel in a solid state, and the other, which is soluble, remains in solution among the liquid contents of the vessel. In this process, advantage is taken of a beautiful law of combination, which is of very extensive operation: this law is called the law of definite proportions, whereby substances unite in certain fixed and well-known proportions, and refuse to unite in any other: thus, in sulphate of lime, 40 parts of sulphuric acid unite with 28 part of lime (by weight); and in sulphate of magnesia, 40 parts of acid unite with 20 of magnesia. These proportions being always and everywhere the same, it follows that the manufacturer of Epsom salts can easily calculate beforehand the quantity of sulphuric acid necessary to be added to any given quantity of magnesian limestone.

The solution of sulphate of magnesia obtained in the above process is drawn off, filtered (that is, strained, in order to free it from solid impurities), and then set aside to crystallize.

As an example of the formation of Epsom salts, the following little experiment, which is by no means difficult to perform, may be interesting:—Take a wine-glass about two-thirds full of water, and add to it about 20 or 30 drops of sulphuric acid. Then take a little common magnesia, and add it to the dilute acid: keep adding so long as there is an effervescence. When this ceases, and the solution is quite clear and limpid, all the acid is neutralised, and a solution of sulphate of magnesia is formed. Pour this solution into a saucer, and set it by in a warm place, such as on the chimney-piece; and in a few days crystals of Epsom salts will begin to appear: in a few days more, all the liquid will dry up, and nothing but solid salt will remain. This simple experiment will show the reader one method by which chemical compounds are formed. Sulphuric acid is an intensely sour, corrosive, and poisonous substance; magnesia is mild and tasteless, and insoluble in water: whereas the union of these two bodies produces a substance whose properties are altogether different from those of its component parts. Sulphate of magnesia is intensely bitter,* very soluble in water, and is not in any degree poisonous.

The process for obtaining Epsom salts from magnesian limestone is sometimes varied by digesting (*i.e.* steeping) the stone in as much muriatic acid as will dissolve the lime only; and after washing the resulting compound with water, adding an equivalent quantity of sulphuric acid. "This," says Dr. Ure, "is certainly the simplest and most profitable process for manufacturing this salt upon the great scale."

Sulphate of magnesia is obtained in Italy from schistose minerals, which contain sulphur and magnesia. These minerals are roasted, and then moistened and exposed to the air for a few months, during which time the salt forms on their surface. By solution in water, with the addition of a small quantity of lime to throw down any metallic substance in solution, and by repeated crystallizations, the salt is obtained pure.

This salt also occurs abundantly in alum-works; but its separation and purification are too expensive to make this a source from whence commerce may be supplied with this useful article.

We have stated that Epsom salts occur in sea-water. In the process of obtaining culinary salt from sea-water, a liquor drains off from the sea-salt after it has been removed from the boiling-pans. This liquor contains Epsom salts, and is called bittern, or bittern water. As the operations for obtaining salt from sea-water are carried

* Hence the salt is called *Sel amer* by the French, and Bitter-salz by the Germans.

on in summer, all the bittern obtained in the process is collected in pits lined with clay and reserved for the winter, when the manufacture of Epsom salts takes place. This bittern is pumped up into the salt-pans, and boiled for several hours, in proportion to its strength. The scum which rises is carefully removed; and when a thin pellicle of salt forms on the surface, the proper degree of concentration is attained. The fires are then put out, and the liquor left till the following day; it is then drawn off, and left to crystallize. This process depends greatly on the state of the atmosphere: on a fine clear frosty night, a crop (as it is called) of crystals is often obtained, which, in less favourable weather, would require a whole week to produce. When the liquor yields no more crystals, it is allowed to run off into the pit. In this way, successive portions of bittern are treated, until the quantity of salt produced is insufficient to pay for fuel and wages: the bittern is then said to be dead, the pits are opened, and the liquor is allowed to flow into the sea. Epsom salts thus procured have been found to retain a little sea-salt, which makes them liable to become moist by exposure to the air. The late Dr. Henry, however, obtained a patent for a process whereby this defect was entirely obviated.

Epsom salts are sometimes found native. They are found in the quicksilver-mines in Spain, mixed with the soil. They are also found occasionally as a fine incrustation on damp walls of cellars and new buildings. There is also a cave a mile and a quarter long near Jeffersonville in the United States, called the Epsom-Salt Cave, whence immense quantities of that substance are procured.

Sulphate of magnesia is colourless when pure; but it often contains a minute quantity of iron, which on exposure to the air gives it a reddish tint. Epsom salts dissolve in their own weight of water at 60°, and in somewhat less than three-fourths of their weight of boiling water.

Oxalic acid has frequently been mistaken for Epsom salts, and fatal consequences have attended the mistake. The reader will find a few precautions on this subject in a paper on Oxalic Acid, in the 'Penny Magazine,' No. 430.

THE HARVEST MOUSE.

White, of Selborne, who suggests the name of *Mus minimus*, appears to be the first who drew the attention of naturalists to this the smallest of British quadrupeds. He wrote an account of it to Pennant, who called it the *Less long-tailed Field Mouse* and the *Harvest Mouse*. White thus introduces his discovery to Pennant: "I have procured some of the mice mentioned in my former letter, a young one and a female with young, both of which I have preserved in brandy. From the colour, size, shape, and manner of nesting, I make no doubt but that the species is non-descript. They are much smaller and more slender than the *Mus domesticus medius* of Ray, and have more of the squirrel or dormouse colour; their belly is white; a straight line along their sides divides the shades of their back and belly. They never enter into houses; are carried into ricks and barns with the sheaves; abound in harvest; and build their nests amidst the straws of the corn above the ground, and sometimes in thistles. They breed as many as eight at a litter, in a little round nest composed of the blades of grass or wheat. One of these I procured this autumn, most artificially platted, and composed of the blades of wheat, perfectly round, and about the size of a cricket-ball, with the aperture so ingeniously closed, that there was no discovering to what part it belonged. It was so compact and well fitted, that it would roll across the table without being decomposed, though it contained eight little mice that were naked and blind. As this nest was perfectly full, how could the dam come at her litter respectively so as to administer a teat to each? Perhaps she opens different places for that purpose, adjusting them again when the business is over; but she could not possibly be contained herself in the ball with her young, which moreover would be daily increasing in bulk. This wonderful procreant cradle, an elegant instance of the efforts of instinct, was found in a wheat-field, suspended in the head of a thistle." And again "As to the small mice, I have further to remark, that though they hang their nests for breeding up amidst the straws of the standing corn above the ground, yet I find that, in the winter, they burrow deep in the earth, and make warm beds of grass; but their grand rendezvous seems to be in corn-ricks, into which they are carried at harvest. A neighbour housed an oat-rick lately, under the thatch of which were assembled near an hundred, most of which were taken, and some I saw. I measured them, and found that from nose to tail they were just two inches and a quarter, and their tails just two inches long. Two of them, in a scale, weighed down just one copper half-penny, which is about the third of an ounce avoirdupois; so that I suppose they are the smallest quadrupeds in this island. A full-grown *Mus medius domesticus* weighs, I find, one ounce lumping weight, which is more than six times as much as the mouse above; and measures from nose to rump four inches and a quarter, and the same in its tail. . . . As my neighbour was housing a rick, he observed that his dogs devoured all the little red mice they could catch, but rejected the common mice; and that his cats ate the common mice, refusing the red." Thus far White. Dr. Gloger describes one of these nests as beautifully constructed of the panicles and leaves of three stems of the common reed interwoven together, and forming a roundish ball, suspended on the living plants about five inches from the ground. On the side opposite the stems, rather below the middle, was a small aperture, which appeared to be closed during the absence of the parent, and was scarcely observable even after one of the young had made its escape through it. The inside, when examined with the little finger, was found to be soft and warm, smooth, and neatly rounded, but very confined; it contained only five young; but another, less elaborately formed, sheltered no less than nine. The panicles and leaves were slit into minute strips or strings by the teeth of the animal, in order to assist the neatness of its weaving. Mr. Macgillivray found one of these nests in Fifeshire composed of dry blades of coarse grass, arranged in a globular form, and placed in the midst of a tuft of *Aira cæspitosa*, nine inches from the ground: it contained six or seven young, naked and blind. The food of this little mouse consists of corn and grass-seeds, insects, and earth-worms: one to which a bit of the tail of a dead blind-worm, *anguis fragilis*, was presented, devoured it greedily. Of insects it is very fond. Mr. Bingley says, "One evening, as I was sitting at my writing-desk, and the animal was playing about in the open part of its cage, a large blue fly happened to buzz against the wires. The little creature, although at twice or thrice the distance of her own length from it, sprang along the wires with the greatest agility, and would certainly have seized it, had the space between the wires been sufficiently wide to have admitted her teeth or paws to reach it. I was surprised at this occurrence, as I had been led to believe that the Harvest Mouse was merely a granivorous animal. I caught the fly, and made it buzz in my fingers against the wires. The mouse, though usually shy and timid, immediately came out of her hiding-place, and running to the spot, seized and devoured it. From this time I fed her with insects whenever I could get them; and she always preferred them to every other kind of food that I offered her." Mr. Macgillivray figures one in the coils of an earth-worm which it devoured, though the worm at first upset it by twisting round its body.

Col. Montagu failed to keep it in confinement, but it has been so kept, The Rev. W. Bingley and Mr. Broderip observed that the tail is in a degree prehensile. The latter had a pair in a dormouse's cage for some time, and frequently saw them coil the end of their tails round the bars, especially when they were clambering along the sides or on the top of it. They became very familiar, soon recognised their friends, and would lie down or rear themselves up to be tickled with a straw or a pen, an operation which they evidently enjoyed much.—*Penny Cyclopædia.*

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